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Analysis of Acoustic Propagation and Scattering Data Across Ship Wakes

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LONG-TERM GOALS

The long-term objective of this work is to contribute to the understanding of propagation and scattering in ship wakes for the purpose of mitigating the potential of detecting and following of wakes by wake-homing torpedoes.

OBJECTIVES

NRL has collected wake-acoustics dataset containing a wide variety of measurements across ship wakes. The goal of this research is to analyze the various data contain in that dataset to determine correlations among the various receiving equipment and scenarios sampled in the dataset. Attempts will be made to interpret these data in terms of various scattering theories for propagation in random inhomogeneous media, such as the Born and/or Rytov approximations, in the various regimes of weak to strong scattering. The ultimate goal will be to interpret the scales and magnitudes of bubble clouds and/or turbulence regimes. Within limitations in the scope of this project, however, we will determine what may offer the greatest impact to be made toward our ultimate goal and to address that selected course of action with analysis and publication of the results.

APPROACH

The NRL wake dataset contains a series of attenuation measurements for wake ages as determined from a pair of ships (a transmitting and a receiving ship) maneuvering down the wake on either side after the wake-generating ship passed between them. The measurements were made using two Navy ships, the *Neptune* (twin-jet propulsion) (see Fig. 1) and the *Athena* (standard twin screws) as wake generators. The towed source on the transmitting ship transmitted pulsed CWs from 30 to 140 kHz, across the *Neptune* wake, to the receive ship that was towing a horizontal line of ten independent hydrophones at a fixed depth of three meters. In the *Athena* experiment, the same line of hydrophones was successively towed at four different depths. In these cases several runs were made at different wake-generating-ship speeds.

The team of Stanic, Caruthers, and Goodman (recently deceased) have published a number of papers on the subject of bubbles. The most recent work by this team was the initial analysis of the wake

dataset for the *Neptune* wake [1]. The approach undertaken in that work involved the analysis of attenuation of the signals propagating across the wake. The plan for this new work is to apply the same approach to the *Athena* wake data. But further, to apply higher-order statistical theories to the *Athena* data. To accomplish that analysis we began a review of the various theories that may be appropriate for the analysis of acoustic propagation and scattering in random inhomogeneous media.

WORK COMPLETED

That review is currently underway an should result in an interim report by yearend.

RESULTS

Having begun the project in February of this year, have no results to report at this time. The report mentioned above will be the first tangable results to be delivered.

IMPACT/APPLICATIONS

The application of this work will be contributions to defense against wake-homing torpedos.

RELATED PROJECTS

This work will contribute to the results of a wake study underway at the Naval Research Laboratory conducted by Dr. Steve Stanic, Acoustics Division, NRL at Stennis Space Center.

REFERENCES

[1] S. Stanic, J.W. Caruthers, R.R. Goodman, E. Kennedy, R.A. Brown, "Attenuation Measurements Across Surface-Ship Wakes and Computed Bubble Distributions and Void Fractions," *IEEE J. Oceanic Eng*., v. 34, n. 1, pp. 83-92, 2009.